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Effect of dietary Castor Oilseed on Production Performance and the Digestion Factor in Awassi Lambs

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Abstract: This experiment aimed to study the effect of different concentration levels of castor oil seed on production performance and the feed digestion factor in Awassi lambs. It used 15 male Awassi lambs, with an average live-weight of 20.60±0.42 kg and aged 3.5-4.0 months. They were randomly distributed to three treatments (T1-T3). Castor oil seed was supplemented with concentrate diet at the levels of 140 mg/lamb/day, 280 mg/lamb/day and compared with the control group (free castor oil concentrate ration) for 90 days. The lambs were randomly penned indoors in individual cages. The concentrate diet was supplied once a day at 2.5% of live body weight and the straw was given as free. The results have shown high significant (P<0.01) differences in the amount of concentrate feed intake. Third treatment (T3) (concentrate diet treated by 280 mg castor oil seed) was superior as compared with other treatments. The results pointed to high significant (P<0.01) increased in total body weight (daily and weekly gain) and feed conversion ratio of animals fed castor oil seed with concentrate diet compared with unfed animals. The current results have also shown that supplementing castor oil seed in concentrate diet was significantly (P<0.01) increased the total digestible nutrient, dry matter, organic matter, ether extract, crude protein, raw fiber, and nitrogen-free extract as well as a significant increase (P<0.05) in digestion coefficient. It is concluded that the addition of castor oil seed to the diet at 208 mg/lamb/day gave the best results by improvement of the productive parameters and digested nutrients of Awassi lambs.

Keywords: Castor oil seed, Concentrate diet, Wheat straw, Awassi lambs.

Introduction

Fat and carbohydrate are the main energy sources in animals' diets. Fat contains carbon, hydrogen, and oxygen. The proportion of hydrogen in fat body structure is higher than carbohydrate. Consequently, the amount of energy produced from fat metabolism is double higher than carbohydrate (Yasin & Mohammed, 2010). Fat is an important nutrient component. It provides animals' bodies with the essential fatty acids that bodies cannot make. These fatty acids must be provided via the diet Fat is a carrier of the fat-soluble vitamins include (E, D, A and K). The essential fatty acids can be derived from animals' sources like fish oil or from plantsources such as castor oil, flaxseed oil, sunflower oil, corn oil, and soybean oil (Al-Fadhli, 2011) Essential fatty acids are an

important need for human body maintenance, normal formation, cellular membrane functions, and enzymatic activity (March, 1992; Ibeas *et al*,: 1994). In a study set out in 2003, Stillwell & Wassall (2003) found the existence of essential fatty acids are necessary for some metabolic processes, and nerve activity.

The studies on effect of dietary castor oilseed on production performance and the digestion factor in the ruminants were few and the results have been varied, however most of them get positive effect (Zhang *et al*., 2008; Copianchi *et al*., 2012; Maia *et al*., 2012; Valero *et al*., 2014), while no significant differences in pH of the rumen were found when compared five different plant oils in the diet (de Morais *et al*., 2015).

Therefore, this study was conducted to investigate the effect of adding different levels of castor oilseed on sheep concentrate diet to determine the best concentration level which leads to improving production performance and the feed digestibility.

Materials & Methods

1-Housing and growing experiment

Fifteen male of Awassi lambs were randomly housed in individual cages at the animal production farm, faculty of agriculture, the University of Diyala from 22/10/2017 to 23/1/2018. The feeding was gradually introduced to the lambs over a period of 14 days as an adaptation period. Awassi males aged between 3.5 and 4.0 months with the average weight of (20.60 ± 0.42) kg were used in this experiment. Animals were randomly distributed among the three treatments (five animals for each). All the lambs have provided an equal daily ration of concentrate (2.5% of the live body weight) and free hay. T1 or diet containing free castor oilseed (control group), T2 or a diet containing 140 mg/lamb/day of castor oil seed, T3 or diet containing 280 mg/ lamb/day of castor oil seed. The components and chemical composition of the concentrate ration and roughage feed are shown in tables (1, 2 and 3). The concentrate diet was provided once a day and the roughage diet was given freely. Experimental diets were introduced for two weeks as an adaptation period following by 13 weeks of testing periods. The daily amount of feed intake and remained were calculated for 13 weeks. The amount of feed intake offered was adjusted weekly with the increases in body lamb`s weight. The animals were weighed weekly before it was fed in the morning. Daily clean water was offered *ad libitum* during the whole experimental period.

1-Nutrient digestibility experiment

Experimental animals were placed in separate pens and a collection bags were attached. Feces were collected daily for seven continuous days. Experimental feeds are provided to three animals from each treatment taken randomly in the last week of the experiment. Samples of feed and feces were collected and weighed daily. Collected samples were dried at 65 for 72 h, and ground through a 1-mm sieve for chemical analysis.

Chemical analysis

The samples collected of primary feed ingredients, experimental feed diet, and feces were analyzed to estimate the following items: dry matter, organic matter, crude protein, ether extract, fibre, nitrogen-free extract, lignin and ash according to AOAC (1990).

Animal feeding

The lambs were given concentrated diet at 2.5% of live body weight and the roughage (wheat straw) was offered *ad libitum*

throughout the experimental period. The concentrate diet was treated with the addition of castor seed oil (140 mg/head/day, 280 mg/head/day). Caster oil was daily added to the diet to preserve its natural properties. The oil was also placed at the top of the diet and at the front of the animal's reach to ensure that the animals took the full amount of oil.

Statistical analysis

The study data were statistically analyzed using the Completely Randomized Design (CRD) method. Data were analyzed using the software (SAS, 2001) statistical program.

Table (1): Diet formulations and proximate composition.

Ingredients	%
Malted barley	23
Wheat bran	22
Yellow corn crumbled	40
Soybean grape	13
Minerals and vitamins	1
Salt	1
Total	100%

- *Calculated from the table of chemical analysis of Iraqi feed materials (Al-Khawaja *et al*., 1978).

Table (2): Percentage of ingredients and concentrate of experimental diets (% in the dry matter).

Feeding material	Dry matter DM %	Organic Matter OM %	ASH %	Crude Protein CP %	Crude Fiber CF %	Ether Extract EE %	Nitrogen Free Extract NFE %
Malted barley	91.43	86.89	4.54	11.68	7.41	2.06	65.75
Wheat bran	90.15	84.48	5.67	17.11	11.99	4.56	50.80
Yellow corn crumbled	90.19	87.25	2.95	10.09	2.88	4.89	69.38
Soybean grape	90.12	85.13	4.99	48.46	6.58	2.24	27.86
Minerals and vitamins	-	-	-	-	-	-	-
Salt	-	-	-	-	-	-	-

* Al-Ani *et al*. (1998) and Al-Bayati (2013).

Table (3): Chemical composition of the roughage and of the treated and untreated concentrate diet, in the percentages of dry matter.

Ingredients	Hay	T1 or concentrated diet contains free castor oil (Control)	T2 or concentrated diet contains (140 mg/lam/day) castor oil	T3 or concentrated diet contains (280 mg/lam/day) castor oil
Dry matter	92.4	90.34	92.21	93.53
Organic Matter	82.24	86.45	88.07	89.67
Crude Protein	2.12	21.51	16.37	14.41
Ether Extract	1.16	3.39	6.22	9.89
Crude Fiber	36.88	7.21	6.21	4.06
Neutral detergent fibre	80.2	-	-	-
Acid detergent fibre	55.62	-	-	-
Cellulose	35.39	-	-	-
Hemicellulose	31.81	-	-	-
Lignin	9.89	-	-	-
Ash	9.86	4.55	4.12	3.86
Nitrogen free extract	41.98	54.34	58.93	61.31

*Chemical elements analyzed by AOAC (1990)

**NFE = OM-(CP+CF+EE)

The obtained data were analyzed using the following mathematical model:

Yij = m + Ti + eij

Yij = value observed of treatment i, within replication j;i.

M = general mean of the experiment.

Ti = random effect of treatment i

eij = experimental error associated to the Yij

i = 1, 2, 3

j = 1, 2, 3, 4, 5

(Duncan, 1955) was below the probability level of 0.05.

Results & Discussion

Growth experiment

Effect of adding castor oil to concentrate diet on dry matter intake, organic matter, protein, total weight gain (kg), daily weight gain (g), the feed conversion efficiency of experimental animals are presented in table (4). The results of the current study revealed that there was no significant difference (P>0.05) between the consumption values of dry matter, organic matter, and protein of the daily hay intake among the three experimental treatments (Table 4). These findings were consistent with Blummel & Becker (1997) and Morgavi *et al*. (2012).

Results from table (4) presented that adding three different doses of castor oil seed to lamb concentrate diet led to a highly significant increase (P<0.01) in the daily dry matter intake (488.01, 505.09, 662.71) g/day and the daily organic matter intake (361.11, 374.32, 554.87) g/day respectively. The results indicated that there was an increase in T3 on daily dry and organic matter intake (662.71 and 554.87, respectively) as compared with T1 and T2. This increase in the amount of daily dry and organic matter intake may be due to the improvement in the feed digestion factor or improving the efficiency of micro-organisms in the animal's rumen. Kristensen & Harmon (2004) have mentioned that the supplementation of vegetable oils on the ruminant diet increases the rate of feed intake. Present results consistent with the findings of Szumacher et *al*. (2004) and Gunal *et al*. (2014), when adding different levels of vegetable oils in ruminant diets.

Protein intake showed a significant increase (P<0.01) in T3 (186.40) g/day, responding to the supplementation of castor oil seed in concentrate diet as compared with T1 and T2 (105.14, and 133.04 g/day respectively (Table 4). The reason may be due to the presence of vegetable oils as dietary supplements that contain different percentages of fatty acids. Which acts as an inhibitor to the work of bacteria producing ammonia and harmful bacteria found in the rumen. In addition, the rumen bugs reduce their harm effectiveness by removing the group of amine from the chemical composition structure of the proteins. This, in turn, reduces the rate of ammonia production in the rumen. Consequently, increasing the intake of raw protein in the diets and making greater use of microbial protein is the most desirable feed requirements for animal's performance (Newbold *et al*., 2004). These results were inconsistent with Vargas *et al*. (2011).

There was a significant difference (P<0.01) for total weight at the dose 280 mg/lamb/day of castor oil seed with concentrate diet as compare with dose 140 mg/ lamb/day (Table 4). T3 was observed to be the highest total body gain (15.8) kg, followed by T2 and T1 were recorded at (13.50 and 15.8) kg respectively. The final lambs' weight gain were the result of the cumulative increases in, which reflect the total weight gain at the end of the experiment. The results, were observed a significant difference in the final body weight among the three experimental treatments. Lambs were fed with 280 mg/day castor oil seed showed the highest total weight of 36.80 kg at the end of the experiment. While the animals fed 140 mg/day reached 33.90 kg and the control animals weighted 31.21 kg. It noticed that the positive effect of adding castor oil seed with the concentrate diet on the increase in total lamb weight gain. The present results were consistent with Benchaar *et al*. (2006), Cruz

et al. (2014) and Akande *et al*. (2015). The rate of lamb daily weight gain (g) increases among the three different levels of adding castor oil seed with concentrate ration was presented in table (4). There was a significant increase (P<0.01) in the rate of the lamb daily weight of (120.11, 150.00, 148.55) g/day for the T1, T2, and T3 respectively.

Table (4): Effect of adding castor oil to concentrate feed on dry matter, consumed organic matter, consumed protein, total weight gain (kg), daily increase (g), feed conversion efficiency of experimental animals (averages ± SD).

Traits		Treatments			Overall average	Sig.
Items	Diet type	T1 Control	T2 140 Castor oil mg/head/day	T3 280 Castor oil Mg/lam/day		
Dry Matter intake g/day	Concentrate	488.01±39.19B	505.09±19.39B	662.71±6.36A	551.94±30.59	**
	Hay	333.57±28.21	326.79±25.8	310.16±24.31	323.50±13.54	N.S
Organic Matter g/day	Concentrate	361.11±27.21B	374.32±15.81B	554.87±7.46A	141.77±12.51	**
	Hay	297.97±25.20	330.75±8.59	293.06±22.93	307.26±11.74	N.S
Protein intake g/day	Concentrate	105.14±3.08C	133.04±7.18B	186.40±10.54A	141.77±12.51	**
	Hay	7.65±0.65	7.45±0.56	6.74±0.21	7.28±0.29	N.S
Primary weight (Kg)	20.40 ± 0.79		20.40 ± 0.76	21.00 ± 1.08	20.60 ± 0.48	N.S
Final weight F (Kg)	31.21 ± 0.92C		33.90 ± 0.51B	36.80 ± 0.49A	33.97 ± 0.71	**
Total weight (Kg)	10.81 ±0.93C		13.50 ± 0.39B	15.8 ± 0.93A	13.37 ± 0.76	**
Daily weight gain (g)	120.11 ± 11.47C		150.00 ± 4.30B	175.55 ± 10.33A	148.55 ± 8.30	**
The efficiency of feed conversion	6.91 ± 1.36A		5.55 ± 0.27B	5.40 ± 0.55B	5.95 ± 0.73	*

The different characters within the same row between the mean of the treatments indicate significant differences at the probability level of 0.05.

** Mean significant effects at the probability level of 0.01 in the variance analysis table.

* There was a significant difference at level 0.05.

N.S. means that there are no significant differences within one row.

The highest lamb daily gain was recorded 180.00 g/day for the animals fed 280 mg/lamb/day castor oil seed with concentrate diet, while the lowest daily weight gain was

118.89 g/day for the lamb fed free castor oil seed (control). The results were consistent with Wachira *et al*. (2000) who pointed out that there is a positive relationship between increasing the live body weight and the supplementation level of vegetable oil. Serafin *et al*. (2014) also noted that the addition of vegetable oils to the ruminants' diet did not affect rumen fermentation. The present results are consistent with the results of Barros *et al* (2011). However, they not consistent with the findings of Hamid *et al*. (2007); Maia *et al*. (2012); Chuntrakort *et al*. (2014) and Chetna (2016), who found no significant differences on the animals body gain when adding different sources of vegetable oils to feed diets.

It also has been shown by the table (4) a significant increase (P≤0.01) in dietary conversion efficiency between treated and untreated concentrate diet with castor oil seed. Treated treatments (T3 and T2) were higher dietary conversion efficiency 5.40 and 5.55 respectively than untreated treatment (T1) of 6.91. There were no significant differences between the third and second treatments. These results were agreed with Igarashi *et al*. (2007) and Koukolova *et al*. (2010).

Nutrient digestion experiment

The effect of castor oil seed supplementation with concentrate diet on total digested nutrients and digestion coefficient of dry matter, nutrients, and energy metabolism are demonstrated in table (5). The result of the present study revealed that the highly significant differences (P<0.01) were observed in both totals digested nutrients and the coefficient digestion for dry matter in T3 (76.89 and 81.99%, respectively) compared with T1 (63.96 and 67.84%, respectively) and T2 (73.75 and 75.21%, respectively).

Table (5) indicated that T3 was significantly (P<0.01) higher in the coefficient digestion of organic matter (80.48%), the crude protein (76.15%), the ether extract (79.77%), the crude fibre (69.96%), and as compared with T1, which was the lowest coefficient digestion of organic matter, crude protein, ether extract, crude fibre and non-nitrogen extract of (66.96, 61.91, 61.30, 56.55, and 62.53%, respectively). The same table also showed a significant increase (P<0.01) in the nitrogen-free extract of the third treatment (79.77%) as compared with the first treatment (73.34%) and the second treatment (73.37%).

The percentages of energy metabolism in T3 increase significantly (P<0.05) compared to T1 and T2 with a digestion factor of 71.89, 62.53 and 71.47respectively. While no significant differences between the first and second treatments were shown in table (5). The reason for the high nutrient digestibility may be due to the use of dietary supplementation from vegetable oils, including castor oil. Which contains Ricinoleic acid, and a dual group of hydroxyl, that improve rumen fermentation. It has been mentioned by Paschoaloto *et al.* (2016) that Ricinoleic acid is one of the most high-fat acids that lead to increased activity of microorganisms by increasing fermentation processes inside the rumen, which had a major impact on the increase of digestion factor. Most of the results of this study were agreed with and Van Soest (2006), Jalc *et al*. (2007), Maia *et al*. (2012) and Girffilh *et al*. (2016) who observed an increase in the digestion factor of different nutrients when animals fed with different types of vegetable oils. However, the results of this study were not consistent with the results of Mcintosh *et al*. (2003). Probably, the reason is the addition of vegetable oil has the 'ability to change

some physical properties such as viscosity of digested nutrients which can limit the access of digestive enzymes to nutrients in rumen liquid. The above idea was supported by Chetna (2016) who did not find significant differences in nutrient digestion factors with the addition of vegetable oil.

Table (5): Effect of adding castor oil to concentrate diet in total digested nutrients and digestion coefficient of dry matter, nutrients, and energy metabolism % (Averages ± SE).

Items	Treatments			overall average	Sig.
	T1 Control	T2 140 Castor oil mg/head/day	T3 280 Castor oil Mg/lam/day		
Total digested nutrients % TDN	63.96 ± 0.68C	73.75 ± 0.44B	76.89 ± 0.32A	71.53±1.96	**
Dry Matter	67.84 ±0.98C	75.21±1.51B	81.99±1.65A	75.02 ±2.16	**
Organic Matter	66.96 ±0.25B	78.49 ±2.52A	80.48 ±2.75A	75.31 ±2.37	**
Crude Protein	61.91± 1.97B	75.35±1.25A	76.15±2.25A	71.14±2.49	**
Ether Extract	61.30±1.65C	73.40±2.34B	79.77±0.53A	71.99±3.04	**
Crude Fibre	56.55±2.12B	69.71±0.24A	69.96±1.85A	66.41±1.89	**
Nitrogen-free extract	73.34 ± 1.04B	73.37 ± 0.53B	79.77± 0.53A	75.49±1.13	**
Metabolism energy %	62.53±1.92B	71.47±1.94B	71.89±2.95A	68.49±1.89	*

The different characters within the same row between the mean of the transactions indicate significant differences at the probability level of 0.05.

*There was a significant difference at level 0.05

**Mean significant effects at the probability level of 0.01 in the variance analysis table.

Conclusion

We can conclude that the addition of castor oil seed to concentrate diet at a concentration of 208 mg/lamb/day (the third treatment) was the best in the improvement of the studied trait's including the total increase of weight rate the efficiency of food conversion, total digested nutrients, organic matter, crude protein, ether extract, nitrogen-free extract and metabolizing energy compared to other treatments.

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